VERSION WITH MARKINGS TO SHOW CHANGES MADE TO THE CLAIMS

1. (Four Times Amended) An illumination optical system having a total reflection type light transmitting element, for illuminating a surface to be illuminated, said illumination optical system comprising:

an imaging optical system for forming an image of a light source by use of light from the light source; and

a [light directing] converting optical system for directing light from the light source image formed by said imaging optical system, to the light transmitting element, [wherein light incident on the light transmitting element has] said converting optical system having a numerical aperture, at [an entrance surface of] the light transmitting element side[,] which is [smaller] not greater than a numerical aperture of [light incident on said light directing optical system, at an entrance surface of said light directing optical system] the light transmitting element.

2. (Amended) An illumination optical system having a total reflection type light transmitting element, for illuminating a surface to be illuminated, said illumination optical system comprising:

an imaging optical system for forming an image of a light source upon a predetermined plane by use of light from the light source, wherein a luminous intensity distribution upon the predetermined plane has a distribution of a shape with a central void;

[a total reflection type light transmitting element;] and

a [light directing] converting optical system for directing light from the light source image formed by said imaging optical system, to said light transmitting element, said converting optical system being effective to make a luminous intensity distribution upon a light entrance surface of said light transmitting element into a distribution of a shape without a central void;

wherein [the numerical aperture of said light directing optical system on the light transmitting element side thereof is smaller than the numerical aperture of said imaging optical system on the light transmitting element side thereof; and

wherein a surface to be illuminated by said illumination optical system is illuminated with light from the light source as transmitted by said light transmitting element] a diameter of flux of light upon the predetermined plane is substantially equal to a diameter of flux of light upon the light entrance surface of the light transmitting element.

3. (Amended) An illumination optical system according to Claim 2, wherein the light source image formed by said imaging optical system has an illuminance

which is larger in a portion adjacent an optical axis of the light transmitting element than in a peripheral portion about the optical axis.

4. (Amended) An illumination optical system according to Claim 2, wherein said imaging optical system includes an elliptical mirror, wherein the light source is disposed at one focal point of said elliptical mirror, and wherein the light source image [is] formed by said imaging optical system is defined at another focal point of said elliptical mirror.

6. (Amended) An illumination optical system according to Claim 2, wherein said [imaging] converting optical system includes first and second lens units having the same focal distance and being disposed so that a distance between principal points of the two lens units becomes equal to the focal distance, and wherein an entrance pupil of the first lens unit is disposed substantially in coincidence with the light source image formed by said imaging optical system, while an exit pupil of the second lens unit is disposed substantially in coincidence with a light entrance surface of said light transmitting element.

7. (Amended) An illumination optical system according to Claim 2, wherein said [imaging] converting optical system includes an optical rod and a lens unit,

wherein a light entrance surface of the optical rod is disposed substantially in coincidence with the light source image formed by said imaging optical system, and wherein one focal point position of the lens unit is disposed substantially in coincidence with a light exit surface of the optical rod, while another focal point position of the lens unit is disposed substantially in coincidence with a light entrance surface of said light transmitting element.

8. (Amended) An illumination optical system according to Claim 2, wherein said imaging optical system includes fly's eye lens and a lens unit, wherein a light entrance surface of the fly's eye lens is disposed substantially in coincidence with the light source image formed by said imaging optical system, and wherein one focal point position of the lens unit is disposed substantially in coincidence with a light exit surface of the fly's eye lens, while another focal point position of the lens unit is disposed substantially in coincidence with a light entrance surface of said light transmitting element.

11. (Amended) An illumination optical system for illuminating a surface to be illuminated, with light from a light source and by use of an optical fiber bundle, said illumination optical system, comprising:

an imaging optical system for forming an image of a light source by use of light from the light source; and

a [light collecting] converting optical system for directing light from the light source image formed by said imaging optical system, to the optical fiber bundle [and being effective to make small the], said converting optical system having a numerical aperture [thereof] at the optical fiber bundle side which is not greater than a numerical aperture of the optical fiber bundle.

12. (Amended) An illumination optical system, for illuminating a surface to be illuminated, with light from a light source and by use of an optical fiber bundle, said illumination optical system comprising:

an imaging optical system for forming an image of a light source on a predetermined plane, by use of light from the light source, wherein a luminous intensity distribution upon the predetermined plane has a distribution of a shape with a central void;

[an optical fiber bundle;] and

a [light directing] converting optical system for directing light from the light source image formed by said imaging optical system, to said optical fiber bundle, [wherein the numerical aperture of said light directing optical system on the optical fiber bundle side thereof is smaller than the numerical aperture of said imaging optical system on the optical fiber bundle side thereof;

wherein a surface to be illuminated by said illumination optical system is illuminated with light from the light source as transmitted by said optical fiber bundle] said

converting optical system being effective to make a luminous intensity distribution upon a light entrance surface of said optical fiber bundle into a distribution of a shape without a central void;

wherein a diameter of flux of light upon the predetermined plane is substantially equal to a diameter of flux of light upon the light entrance surface of said optical fiber bundle.

13. (Twice Amended) An illumination optical system according to Claim 12, wherein the light source image formed by said imaging optical system has an illuminance which is larger in a portion adjacent an optical axis of the light transmitting element than in a peripheral portion about the optical axis.

14. (Amended) An illumination optical system according to Claim 12, wherein said imaging optical system includes an elliptical mirror, wherein the light source is disposed at one focal point of said elliptical mirror, and wherein the light source image [is] formed by said imaging optical system is defined at another focal point of said elliptical mirror.

16. (Twice Amended) An illumination optical system according to Claim 12, wherein said [imaging] converting optical system includes first and second lens units

having the same focal distance and being disposed so that a distance between principal points of the two lens units becomes equal to the focal distance, and wherein an entrance pupil of the first lens unit is disposed substantially in coincidence with the light source image formed by said imaging optical system, while an exit pupil of the second lens unit is disposed substantially in coincidence with a light entrance surface of said optical fiber bundle.

17. An illumination optical system according to Claim 12, wherein said [imaging] converting optical system includes an optical rod and a lens unit, wherein a light entrance surface of the optical rod is disposed substantially in coincidence with the light source image formed by said imaging optical system, and wherein one focal point position of the lens unit is disposed substantially in coincidence with a light exit surface of the optical rod, while another focal point position of the lens unit is disposed substantially in coincidence with a light entrance surface of said optical fiber bundle.

18. (Amended) An illumination optical system according to Claim 12, wherein said [imaging] converting optical system includes a fly's eye lens and a lens unit, wherein a light entrance surface of the fly's eye lens is disposed substantially in coincidence with the light source image formed by said imaging optical system, and wherein one focal point position of the lens unit is disposed substantially in coincidence

with a light exit surface of the fly's eye lens, while another focal point position of the lens unit is disposed substantially in coincidence with a light entrance surface of said optical fiber bundle.

22. (Amended) An illumination optical system <u>having a total reflection type light transmitting element, for illuminating a surface to be illuminated, said illumination optical system</u> comprising:

[light directing means for directing light to a predetermined plane, wherein the light includes plural light beams to be incident on the predetermined plane at different angles;

a total reflection type light transmitting element; and

a light directing optical system for directing light from the predetermined plane to said light transmitting element, wherein the numerical aperture of the light emitted from said light directing optical system is smaller than the numerical aperture of the light impinging on the predetermined plane;

wherein a surface to be illuminated by said illumination optical system is illuminated with light from said directing means as transmitted by said light transmitting element]

a light source for illuminating a predetermined plane, wherein a luminous intensity distribution upon the predetermined plane has a distribution of a shape with a central void; and

a converting optical system disposed between the predetermined plane and said light transmitting element, for directing light from the light source to said light transmitting element, said converting optical system being effective to make a luminous intensity distribution upon a light entrance surface of said light transmitting element into a distribution of a shape without a central void;

wherein a diameter of flux of light upon the predetermined plane is substantially equal to a diameter of flux of light upon the entrance surface of said light transmitting element.

24. (Amended) An illumination optical system according to Claim 22, wherein [said directing means] the light source comprises a plurality of laser light sources.

25. (Amended) An exposure apparatus, comprising:

an illumination optical system as recited in any one of Claims [1-8 and 11-24] 1, 2, 11, 12, 22 and 27; and

a projection optical system for transferring, by exposure, a pattern of a mask as illuminated with said illumination [optical] system, onto a wafer.